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CREEP BEHAVIOR OF METALS IN LOW-STRAIN REGION UNDER SLIGHTLY VARYING STRESSES

by

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1. Analysis

Upon receipt of the Research Grant considerable attention was devoted to the analytical development of a creep relation describing the effect of slightly varying stresses. A general drawback of creep equations previously proposed has been their failure to reflect the important mechanisms of material creep, such as work hardening and recovery. In order to take the creep mechanism into account a synthesis of the mathematical model and known physical aspects of creep is required. A preliminary synthesis was developed which is adequate for initial comparisons with experimental results. However further development of the analysis would yield few results at the present stage of the investigation due to the lack of adequate data for comparison purposes. For this reason the major effort of the past three months has been in furthering the experimental program.

2. Experimental Program

The creep testing machine, which was in large part complete when the Grant became effective, was completed and calibrated. Besides the moment arm with a load ratio of 20:1, a loading point was added which provides a load ratio of 5:1. Use of this loading point permits better control of load changes in tests requiring small loads. Two load rings were built and their output calibrated on a multichannel DC recorder. The load ring with a range of 125 kg. (275 lb.) was calibrated by dead-weight loading, and the load ring with a range of 1500 kg. (3300 lb.) was calibrated in a universal testing machine. The output of both load rings is linear, and accurate to within 1 percent of the applied load. Hysteresis of the load rings is negligible. One of the advantages of the recorder being used in the program is that full scale load and a change of a fraction of a percent in the load can be read with equal ease and accuracy by switching the amplifier range.

Longitudinal strain of the test specimen is obtained on the recorder simultaneously with the load measurement. Strain is measured by a pair of Kyowa high-temperature strain-gages, placed back-to-back near the midpoint of the test specimen. Alteration of the configuration of the strain-gage bridge by use of a switch facilitates measurement of both longitudinal strain due to tensile creep and lateral deflection due to vibration imposed on the specimen. The strain gages were calibrated at room temperature and at various constant elevated temperatures.

The furnace installed in the testing machine was calibrated under test conditions, in the vicinity of 200°C (392°F). The temperature at any given point on the specimen varied less than ± 1°C over a period of 6 hours, and the overall temperature variation along the specimen gage-length was ± 2°C. The furnace performance is therefore adequate for the purposes of the present tests.

Preliminary strength and creep tests were performed, primarily in order to test the test system as a whole. Some constant and varied load tests were also conducted on commercially (99.4 percent) pure aluminum. Prior to test the commercially pure aluminum was annealled for two hours at 590°C(1100°F) and allowed to cool in the annealing furnace.

The experimental program is progressing satisfactorily, and it is expected that the theoretical development will be able to proceed shortly.